IJHEP | INTERNATIONAL JOURNAL OF HIGHER EDUCATION PEDAGOGIES
ISSN: 2669-2333
VOLUME 4, ISSUE 2

Facilitating Authentic Teaching with 360-Degree Videos

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ABSTRACT

Visiting construction sites by civil or construction engineering students is an engaging way to advance students' understanding of construction and structural engineering design practices. Such visits offer a valuable interactive learning opportunity for students to understand real-world projects that scaffolds their in-class theoretical learning. This teaching practice intends to prepare graduate-ready students for the workforce. Facilitating immersive and interactive 360-degree videos are deemed to overcome challenges associated with implementing site visits, including logistics complexity and safety concerns. This paper demonstrated the development and implementation of authentic learning activities incorporating 360-degree videos taken at construction sites for teaching two engineering subjects delivered at La Trobe University-Australia. The construction-site types are selected to serve the intended learning outcomes of civil engineering subjects that teach the structural design methods for steel, timber and reinforced concrete members. The videos are established pedagogically alongside the projects' authentic construction documents, including structural and architectural drawings. These materials are collectively used to establish industry-driven activities for students to learn and practise real-world engineering tasks with onsite exposure enabled through 360-degree videos. Findings from quantitative and qualitative analyses examining students' perceptions of learning from 360-degree videos are reported in this paper. A 10-item survey was created to measure students' reflections on using the 360-degree videos to understand the intended skills, engagement in learning, and the development of their employability skills. From receiving 23 responses to the survey, on average, 94.8% of the participating students reflected their agreement with finding 360-degree videos supporting their understanding, engagement and employability measures, with 80% being in strong to complete agreement.

Keywords: 360-degree video, construction site visits, immersive technology, Technology Enhanced Learning

Cite this article as: Al Abadi, H. (2023). Facilitating Authentic Teaching with 360-Degree Videos. *International Journal of Higher Education Pedagogies*, 4(2), 43-51. https://doi.org/10.33422/ijhep.v4i2.454

1. Introduction: Advancing study performance with 360-degree videos

The use of 360-degree videos is on the rise in the education sector because they provide an immersive and captivating experience. These videos allow students to experience different environments and scenarios that they may not have the opportunity to experience in real life. 360-degree videos also allow for interactive learning experiences, where students can control the direction and pace of the video to focus on specific areas of interest. The potential of this technology is to revolutionize the teaching and learning process, creating a more engaging and memorable experience for students (Rosendahl & Wagner, 2023).

In recent years, there has been a significant increase in the utilization of 360-degree videos in higher education. These videos offer an immersive and engaging experience that allows students to explore different environments and scenarios they may not have the opportunity to experience in real life. They offer a unique perspective on the subject matter and allow students to explore different angles and viewpoints. According to a literature review, this technology has been used in various fields, including engineering, sciences, health science and physical education, to provide students with a more interactive and memorable learning experience (Ranieri et al., 2022).

In civil, structural, and construction engineering courses, students participate in field trips or visit construction sites to gain hands-on experience and apply the skills they learn in real-world scenarios. This interactive learning experience enhances their understanding of the subject matter. Eiris Pereira and Gheisari (2019) define three essential components of a site visit, the learning objectives, the spatio-temporal occasion, and the interactivity forum. The learning objectives of the 360-vidoes demonstrated in this paper are determined by the intended learning outcomes aimed by the subjects which facilitates the videos as part of their learning activities. Exposing the student to actual environment where engineering components can be related to the surroundings present the spatiotemporal occasion component, for example, educating the students about how a particular framing member within a building is restrained by the surrounding structural elements. The interactive forum component is delivered by the proposed 360-degree videos through demonstrating the various stakeholders' roles in planning, design, and construction phases for a particular development.

Recent research indicates that 360-degree videos can enhance student engagement and retention compared to traditional 2D videos (Dhimolea et al., 2022; Makransky & Lilleholt, 2018). This is because viewers of 360-degree videos have the freedom to look around and explore different parts of the scene, resulting in a more immersive experience. Furthermore, a study by Rupp et al. (2019) reported that students who utilized immersive technologies achieved higher scores than those who used less immersive technologies. This could be attributed to the immersive nature of 360-degree videos, which can aid students in comprehending and retaining complex concepts more effectively. Ranieri et al. (2022) have also reported that one of the key advantages of using 360-degree videos is that they offer a more engaging and interactive learning experience. With traditional videos, students are passive viewers limited to a fixed camera angle. In contrast, using 360-degree educational videos enables students to engage with the content and actively explore their environment. This can lead to better retention of information and increased student engagement.

Incorporating 360-degree videos in higher education has the potential to transform the way we teach and learn. This innovative technology offers students an immersive and interactive learning experience, resulting in improved engagement and retention. Consequently, educators across different disciplines can benefit from using it as a valuable teaching tool (Gänsluckner et al., 2017; Lee et al., 2017).

Lampropoulos et al. (2021) noted that the growth of online content, more affordable and effective technology, and progress in mobile tech had caused a surge in the use of 360-degree video and immersive technologies for education. As a result of these changes, there is now a significant and quickly expanding collection of online 360° videos available due to the integration of this technology on social media platforms and the increased availability of affordable equipment (Snelson & Hsu, 2020).

360-degree videos provide a feeling of being present and fully engaged in the learning environment. This can be particularly helpful for students who are learning in a remote or online environment, as it can help to create a sense of connection and community. Additionally, 360-degree videos can be used to simulate real-world scenarios, which can help to prepare students for future careers and experiences.

Overall, the use of 360-degree videos can potentially change how students learn. It offers an immersive, interactive learning experience that increases student engagement and information retention. Additionally, it helps prepare students for their future careers and experiences.

2. Aim and research question

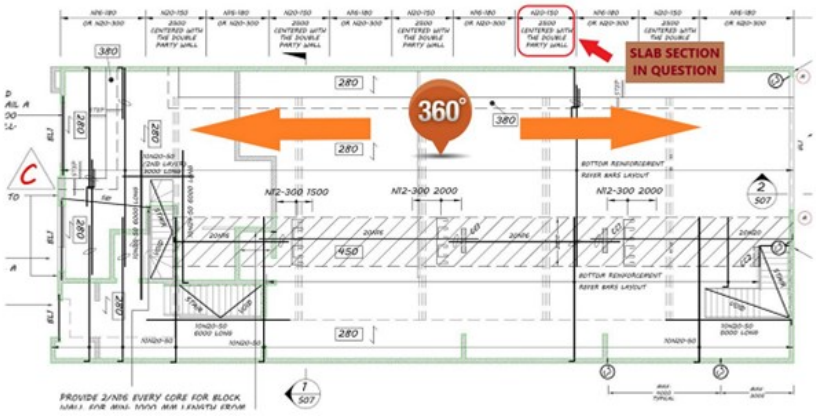
Student safety is often a significant concern when using site visits as educational opportunities. Busy and active construction sites can pose potential hazards, which may limit the number of visits and the quality of education offered (Mills et al., 2006). As a result, this paper proposes developing and integrating 360-degree videos taken at selected construction sites into the teaching curriculum for two engineering subjects delivered at La Trobe University-Australia. The videos are aimed to serve as authentic structural design case studies for enabling students to engage with the material and develop industry-driven engineering skills.

In addition to facilitating the videos, students are provided with architectural and structural engineering drawings for each project. These additional resources enhance the learning experience by providing further insights into the subject matter. This approach enabled students to gain valuable knowledge about framing building components while mitigating potential risks to themselves or others.

Students have a comprehensive and hands-on learning experience by incorporating these tools into the curriculum. Furthermore, this approach advanced understanding of the subject while overcoming the logistical, health and safety challenges associated with on-site visits. This solution benefits students and educators by providing a safe and effective way to learn about structural engineering.

3. Designing authentic learning activities using 360-degree videos

For establishing authentic educational materials, 360-degree videos recorded at construction sites are used alongside the projects' architectural and structural engineering drawings. These materials are pedagogically presented to the students in a self-explanatory instruction through the university's online Learning Management System (LMS) available for each subject. The videos and real-world structural design materials present the tools for the students to practice during their workshop classes. Figure 1 shows an example of a part plan of structural drawings indicating the recorded pathway of a suspended concrete slab (Figure 1a). Figure 1b presents an image of the 360-degree video recording of the slab's as-built condition along the pathway indicated in Figure 1a. These materials intend to support students' visualization of real-world conditions alongside utilizing industry-based documents represented by the structural drawings when learning how to calculate structural loading. Figure 1c shows an image of the 360-degree video demonstrating the reinforcement placement for the concrete slab, which supports students learning of the structural design skills, including the sizing and installation processes of the reinforcement bars.



1a: Part plan of structural engineering drawings for a reinforced concrete slab used to teach a structural design subject. The arrows indicate the parthway used to record the 360-degree videos.

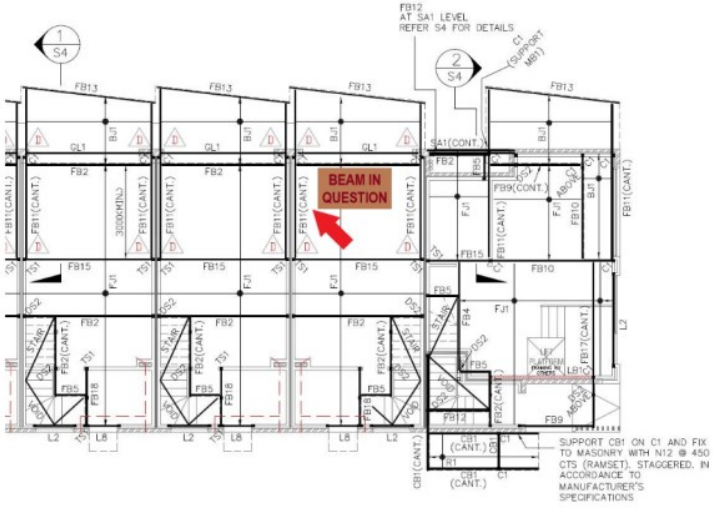
1b: A captured image from the 360-degree video was recorded above the concrete slab while placing the slab's steel reinforcement before pouring the concrete (Al Abadi, 2020b).

1c: A captured image from the 360-degree video recorded under the as-built concrete slab (Al Abadi, 2020c).

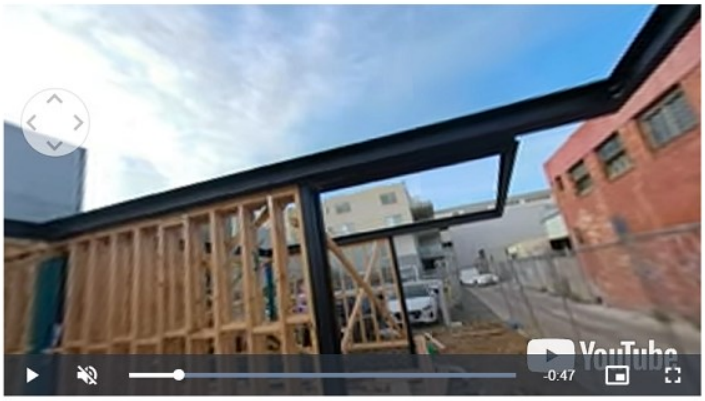
Figure 1. Facilitating 360-degree videos in teaching structural subject for designing reinforced concrete. slab

Students can better understand structural engineering design skills with the help of job-site experience. The 360-degree technology takes this experience to the next level by demonstrating the integration between design details and the surrounding environment. This provides a complete picture for students to grasp complex project-specific constraints related to structural designs and construction sequencing. Traditional methods, such as site tours using PowerPoint or time-lapse videos, can limit their ability to provide the same level of understanding.

Figure 2 shows another example of a part plan from structural drawings indicating the recorded pathway of timber-steel framing floor (Figure 2a). Figure 2b presents an image of the provided 360-degree video recording of the framing arrangement for the beam in question. These materials are part of the teaching lessons for designing timber and steel framing members.



2a: Part plan of structural engineering drawings for a first floor timber framing plan used to teach a structural design subject.



2b: A captured image from the 360-degree video recorded steel beam installation during the construction process (Al Abadi, 2020a).

Figure 2. Facilitating 360-degree videos in teaching structural subject for desinging timber-steel members

4. Evaluation methodology for the developed 360-degree videos

Participants included 23 undergraduate students enrolled in a structural engineering subject whose workshop classes facilitate the use of 360-degree authentic videos. The participants responded to requests to complete anonymous surveys conducted through three academic years, 2020 to 2022, which were open for the students after completing authentic learning activities. The learning activities were delivered to teach three primary structural engineering skills over six weeks (of the standard twelve academic weeks) for two construction projects, including loading calculations, designing steel beams for strength and designing steel beams for serviceability.

A ten-question survey was conducted to assess the participants' comprehension and engagement level with the skills taught in the videos. The questions were rated on a seven-point Likert scale, as listed in Table 1 (Completely Disagree, Strongly Disagree, Somewhat Disagree, Neither Agree nor Disagree, Somewhat Agree, Strongly Agree and Completely Agree).

The statements are created to measure critical criteria represented by advancing students' understanding of the intended skills (statements S1 to S3), engagement in learning (statements S4 to S6) and employability skills (statements S7 and S8). Statements 9 and 10 aimed to measure students' agreement with how adequately the videos can replace the site

visit experience. It should be noted that statement 10 refers to the COVID-19 lockdown situation.

Table 1.
Questionnaire statements in relation to the use for the 360-degree videos

Statement reference	Question statements	Response options
S1	The real-world activities enabled me to achieve the learning outcomes in terms of genuinely **understanding** the process of structured engineering members	• Completely disagree • Strongly disagree • Somewhat disagree • Neither agree nor disagree • Somewhat agree • Strongly agree • Completely agree
S2	Provided recourses, including engineering and architectural drawings alongside the 360°- videos, have facilitated a clear **understanding** of the onsite/as-built conditions.	
S3	The 360°- videos have enabled complementing my theoretical **understanding** of the structural design process taught in the subject.	
S4	The 360°- videos have facilitated enhancing my **engagement** in studying the intended structural design skills of the subject.	
S5	The 360°- videos have contributed to establishing an **intellectually stimulating** learning experience.	
S6	I would **recommend practicing** further authentic case studies in this subject while studying other engineering subjects.	
S7	The real-world case studies have guided me to practice such skills as a **graduate student**.	
S8	The step-by-step application of the engineering design standards in a real-world case study demonstrated the **importance of design standards** to me.	
S9	I found the 360°-videos can **adequately substitute** the need to undertake onsite visit for observing the beam's framing arrangements of the case studies.	
S10	Although an onsite visit was not possible due to the current situation, I think this module provided an **adequate replication** of real-world experience.	

5. 360-degree videos impact on students' engagement and success

From 2020 to 2022, student surveys were conducted for three academic years to evaluate the effectiveness of 360-degree videos in teaching activities. The surveys received 23 responses to the statements outlined in Table 1. Table 2 displays the level of agreement from students regarding their learning experience with the 360-degree videos.

Students' level of agreement reported in Table 2 demonstrates their broad agreement with finding the 360-degree videos advancing their learning experiences. They reflected an average of 95.5% agreement in scaffolding their understanding for the intended to-learn skills, with 82% being in strong to complete agreement. 94.9% of the surveyed students agree with finding the videos advancing their engagement with practicing the learning activities, with 77% in strong to complete agreement. Experiencing industry-based practices that contribute to their engineering employability with the use of the videos is agreed by 94% of the students, with 80.3% of them in strong to complete agreement.

Table 2.
Student reflection to the use for 360-degree videos

Statement reference (See Table 1)	Measured criteria	360-degree use in 2020		360-degree use in 2021		360-degree use in 2022	
		Students agreed with the statements	Students strongly-completely agreed with the statements*	Students agreed with the statements	Students strongly-completely agreed with the statements*	Students agreed with the statements	Students strongly-completely agreed with the statements*
S1	Understanding	92%	92%	100%	71%	100%	80%
S2		92%	75%	100%	86%	100%	80%
S3		76%	68%	100%	86%	100%	100%
Average results for Understanding		**86.6%**	**78.3%**	**100%**	**81%**	**100%**	**86.6%**
		Average of Students agreement: 95.5% **Average of Students strongly-completely agreement: 82%**					
S4	Engagement	84%	59%	100%	72%	100%	60%
S5		84%	59%	86%	71%	100%	80%
S6		100%	92%	100%	100%	100%	100%
Average results for Engagement		**89.3%**	**70%**	**95.3%**	**81%**	**100%**	**80%**
		Average of Students agreement: 94.9% **Average of Students strongly-completely agreement: 77%**					
S7	Employability	92%	67%	86%	72%	100%	80%
S8		100%	92%	86%	71%	100%	100%
Average results for Employability		**96%**	**79.5%**	**86%**	**71.5%**	**100%**	**90%**
		Average of Students agreement: 94% **Average of Students strongly-completely agreement: 80.3%**					
S9	Adequacy	68%	51%	72%	43%	100%	80%
S10		92%	75%	86%	86%	100%	60%
Average results for Adequacy		**80%**	**63%**	**79%**	**64.5%**	**100%**	**70%**
		Average of Students agreement: 86.3% **Average of Students strongly-completely agreement: 65.8%**					

* The values denote the percentage of the responded students.

6. Conclusion

This paper presents the development of authentic learning activities that integrate the use of 360-degree videos taken at construction sites to teach civil engineering students structural design methods. The videos, alongside actual construction documents, including the structural and architectural drawings, are arranged to generate case studies for the students to practice during the workshop classes. Students' uptake of the videos facilitating the delivery of authentic activities is empirically evaluated by investigating students' responses to a survey on the proposed activities.

A 10-item questionnaire survey is used to evaluate students' reflections on their experiences with using the videos. Based on the observations determined from measuring four performance criteria of the 360-degree videos, the following conclusions can be drawn:

- Scaffold students' understanding and engagement criteria received the highest agreements from the students, 95.5% and 94.9%, respectively. All the students (i.e., 100%) reflected the agreements with both these criteria when the authentic activities were delivered in their second and third implementations in 2021 and 2022, respectively.

- Students' employability: 94% of the surveyed students have agreed that finding authentic activities allows them to work on real-world engineering practices that allow them to develop authentic industry-driven skills.
- The adequacy of 360-degree videos: 86.3% of the students agreed that the 360-degree videos adequately simulate the onsite learning experience about the intended to learn structural design skills.

Acknowledgment

The work presented in this paper was supported by Office of the Provost at La Trobe University – Australia.

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